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EFFECT OF PLANTING DATE AND SPACING ON GROWTH, YIELD AND QUALITY OF BEET ROOT (*Beta vulgaris* L.) CULTIVARS UNDER NORTH GUJARAT CLIMATIC CONDITIONS

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ABSTACT

The effect of planting dates *viz.*, 15th October, 30th October, 15th November at three spacing *i.e.*, 15 cm X 15 cm (S_1), 30 cm X 15 cm (S_2) and 30 cm X 30 cm (S_3) on yield and quality parameters of two beet root cultivar *viz.*, Crimson Globe (C_1) and Detroit Dark Red (C_2) was investigated. Among the planting dates, 30th October planting significantly increased number of leaves and leaf area per plant, induced earlier root maturity, improved root width, increased root length and enhanced root yield in terms of root weight per plant and per hectare and marketable root yield. Among three spacing, insignificant difference for number of leaves, leaf area per plant, days taken for root maturity, root width and weight of root per plant were observed between S_2 and S_3 spacing, but differed significantly from S_1. However total root yield per hectare and marketable root yield per hectare was significantly higher in S_2 spacing, whereas, significantly a higher total soluble solids was measured in S_3 spacing. Among the cultivars, cv. 'Detroid Dark Red' recorded maximum number of leaves and leaf area per plant, days taken for maturity and root length, whereas cv 'Crimson Globe' produced higher root width, gained maximum weight of root per plant and yield per hectare. Thus, among all treatment combinations, the 30th October planting with 30 x 15 cm spacing proved superior in terms of growth, and yield attributes *viz.* number of leaves per plant, leaf area per plant and root yield per plant and per hectare and marketable shelf life.

KEYWORDS: Beet Root, Planting Date, Spacing, Cultivars

INTRODUCTION

The table beet, red beet or beet root (*Beta vulgaris* L.) has been an important root crop grown for their fleshy enlarged roots, which has nutritional, culinary, medicinal and industrial significance. Cultivation of beetroot for trade requires standardisation of agrotechniques. Though the agroclimatic conditions of North Gujarat is quite favourable and there is tremendous potential for taking up commercial cultivation of this crop during *rabi* season, the standardisation of horticultural practices has not been done so far under local agroclimatic condition for its profitable cultivation. The present paper gives the information about the planting date and spacing of beet root cultivars for obtaining higher yield.

MATERIALS AND METHODS

Field experiments were conducted at Horticulture Instruction Farm of Department of Horticulture, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University (SDAU), Sardarkrushinagar, Gujarat (latitude 24° 19' N,

longitude 72° 19' E) during the *rabi* season of the year 2014-15 in split plot design with three date of planting *viz.* 15th October (P_1), 30th October (P_2) and 15th November (P_3) as main treatments and three spacing *i.e.*, 15 cm X 15 cm (S_1), 30 cm X 15 cm (S_2) and 30 cm X 30 cm (S_3) and two cultivar Crimson Globe (C_1) and Detroit Dark Red (C_2) as two levels of sub-treatments which were replicated thrice. Seeds of Crimson Globe (C_1) and Detroit Dark Red (C_2) were obtained from IARI Regional Station Katrain, Kullu Valley-175129, Himachal Pradesh. Plots were thinned to appropriate spacing four weeks after planting. All the recommended package of practices was followed to raise a good crop. Ten competitive plants were marked in each net plot per replication and the observations were recorded on various growth and root yield parameters on these plants. The data was statistically analysed using analysis of variance according to the method described by Panse and Sukhatme (1978).

RESULTS AND DISCUSSIONS

Growth Parameters

It is evident from Table 1 that vegetative growth of beet root was markedly influenced by the planting date and the significantly maximum number of leaves per plant and largest leaf area per plant was obtained from 30th October planting (11.40 and 1533.24 cm^2, respectively). The increase in number of leaves and leaf area in 30th October planting may be due to favourable growing conditions which might have resulted in luxuriant growth of these vegetative characters. The results are in accordance with finding of Alam, *et al.* (2010) and Pandey, *et al.* (2009) in radish. All three spacing under study showed significant variation in number of leaves per plant and leaf area per plant and it was maximum at S_3 spacing, i.e., 30 cm X 30 cm (10.63 and 1455.98 cm^2, respectively), being at par with S_2 (30 cm x 15 cm) spacing (10.26 and 1397.79 cm^2, respectively). Whereas closer spacing (15x15 cm) recorded lowest count of leaves per plant and leaf area per plant, which seems to be mainly due to more competition for nutrition and light, which lead to lesser photosynthesis area. The increment in leaves numbers due to increase in spacing is in consonance with finding of Khogali *et al.,* (2012) in fodder beet (*Beta vulagaris* var. Crassa). Among the cultivars, C_2 *i.e.,* 'Detroid Dark Red' produced maximum number of leaves per plant (10.26) and larger leaf area (1372.71 cm^2/plant) then cv 'Crimson Globe'. Similar significant cultivar effect on number of leaves per plant was also noticed by Khogali *et al.,* (2012) in fodder beet. Figure 1 and 2, shows the interaction of planting date and spacing produce significant number of leaves and leaf area per plant. This may reflect the favourable environment and efficient utilization of available space for root growth (wider spacing with favourable environment). The P x C interaction for leaf area per plant was significantly differed and the largest leaf area was measured with P_2C_2 (1533.73 cm^2), being at par with P2C1 (1532.74 cm^2). This might be favourable environment for growth in 30th October planting date.

Table 1 elucidates that planting date exerted significant effect on time taken for maturity of beet root. 30th October took shortest time for maturity of beet root (76.39 days), being at par with 15th November planting (78.99 days). Among the various spacing S_3 showed significantly earlier maturity of beet root (77.33 days), being at par with S_2 (77.44 days). The cv. 'Crimson Globe' matured earlier (65.41 days), while cv 'Detroit Dark Red' mature late. (92.18 days). This might be due to advanced root maturity nature of cv 'Crimson Globe'. Ijoyah *et al.,* (2008) also reported that the time of maturity could be lined to the genetic control of the varieties, thus the difference in the length of time taken to remain at the vegetative phase before roots are initiated and become matured.

Yield Attributes

Table 2 elucidates that planting dates exerted significant effect on root length. 15th November planting produced maximum roots length (6.50 cm), being at par with 30th October planting (6.41) for root length. Root length was increased with the increasing of planting spacing and, significantly maximum length of root was obtained at S_3 *i.e.,* 30 cm x 30 cm spacing (6.86 cm). A considerable difference was found between the cultivars. On average, the longest roots (6.39 cm) were produced by cv 'Detroid Dark Red'. The difference between the two beet root cultivars under study could be due to the difference in the genetic makeup and their response to the environmental conditions. Moreover, finding of Khogali *et al.,* (2012) in fodder beet is in accordance with the result observed in current investigation in case of cultivars.

Beet root cultivars planted on 30th October had the significantly maximum root width (6.82 cm), being at par with 15th November planting (6.27 cm). The rapid increase in root width was due to more vigorous vegetative growth in the P_2 and P_3 planting, resulting in more photosynthates translocation from leaves to root in radish (Alam, *et al.* 2010). Among the spacing, both S_2 and S_3 attained significantly greater root width at harvesting (6.77 cm and 6.71 cm, respectively) compared to S_1 spacing. Higher root width at wider spacing might be due to reduction in competition for light, moisture and nutrients. Among the cultivars, root width of cv 'Crimson Globe' was significantly higher (6.52 cm) than that of cv 'Detroit DarkRed'. The cultivar differences in root width are in the line with those results obtained by Ijoyah *et al.,* (2008) in beet root and Alam, *et al.* (2010) in radish.

Significant influence of planting date on weight of beet root per plant was observed and it was maximum at 30th October planting (139.82 g) followed by 15th November planting (124.32 g). Similar variation in weight of roots per plant due to planting date were earlier reported by Feller and Fink (2004) in table beet and Pandey *et al*., 2009 and Alam *et al.*, 2010) in radish. Weight of beet root per plant was significantly influenced by spacing and was maximum under S_3 spacing (144.04 g), being at par with S_2 spacing (139.14 g). The higher root weight per plant were due to more number of leaves and leaf area for photosynthesis and efficient utilization of these photosynthates, might have enhanced the better root width, root volume, root length and root yield per plant. Similar findings are in agreement with the findings of Goldman (1995) in beet root. Highly significant difference was measured among the cultivars in respect to weight of root per plant. Higher weight of beet root per plant was obtained from cv 'Crimson Globe' (131.43 g). This result is in agreement with those of Ijoyah *et al.,* (2008) in beet root. The P x S interaction produced higher root weight per plant (Figure 4). This may reflect the favourable environment and efficient utilization of available space for root. Moreover, the findings of Feller and Fink (2004) in beet root in regards to weight of root per plant and yield per hectare is in accordance with the results observed in this experiment.

Planting date had a major effect on total beet root yield per net plot and yield per hectare. 30th October planting gave the maximum root yield per hectare, *i.e.,* 309.28 q, which was highly significant than other planting dates. The increase in root yield with 30th October planting might be attributed to the good weather conditions that promoted photosynthesis and improved growth of beet root, hence increase root yield. Spacing significantly affected root yield per hectare and maximum root yield per hectare (309.15 q) was found at 30 cm x 15 cm spacing. Among the cultivars, cv. 'Crimson Globe' gave maximum beet root yield per hectare (286.16 q). Figure 5, illustrate the interaction of planting date and spacing gave higher root weight per plant and yield (q/ha). This may reflect the favourable environment during vegetative growth to roots growth and efficient utilization of available space for root growth (wider spacing with

favourable environment). Moreover, the findings of Feller and Fink (2004) in beet root in regards to weight of root per plant and yield per hectare is in accordance with the results observed in this experiment.

Marketable root was roots which are greater than 5 cm in width according the assessment of the local market. Highly significant variations were observed among the planting dates, spacing and beet root cultivars. Among the planting dates, P_2 and P_3 showed insignificant difference for marketable root yield per hectare (193.05 and 173.01 q/ha, respectively), but different significantly from P_1 planting (155.60). Marketable beet root yield per hectare was significantly influenced by different spacing and the highest marketable root yield per hectare was obtained with planting at 30 X 15 cm spacing (281.89 q). The optimum plant population in beet root is very necessary to have higher marketable root yield with good quality. Wider spacing than optimum spacing decreases root yield due to low plant population and in very closer spacing plant produces very small roots, which are not fit for market. Benjamin *et al.* (1985) also reported that higher plant density increase the proportion of plants with small roots, usually at expense of total yield. Kikkert, *et al.* (2010) and Tyler *et al.* (1982) also found that yield of "baby root" (1.0-1.7 inches diameter) decreased at higher population density.

Comparison of total soluble solid with planting date and cultivars measured insignificant differences. However, all three spacing under study showed significant variation in total soluble solids and it was maximum (12.74^0Brix) at wider spacing, i.e., 30 x 30 cm.

Marketable shelf life of beet root is very important, especially for regulating beet root produce in market and for distant transport. Among the planting dates, insignificant variation in marketable shelf life of beet roots were observed in 30^{th} October planting and 15^{th} November planting, but was significantly higher than 15^{th} October planting.

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APPENDICES

Table 1: Effect of Planting Time and Spacing on Number of Leaves and Leaf Area per Plant and Days Taken for First Harvesting of Beet Root (*Beta vulgaris* L.) Cultivars

	Number of Leaves per Plant	Leaf Area (cm^2) per Plant	Days Taken for Root Maturity (Days)
15^{th} October (P_1)	8.91	1202.10	81.00
30^{th} October (P_2)	11.40	1533.24	76.39
15^{th} November (P_3)	9.98	1301.93	78.99
C.D. (P = 0.05)	0.68	122.49	3.38
15 cm X 15 cm (S_1)	9.39	1183.50	81.61
30 cm X 15 cm (S_2)	10.26	1397.79	77.44
30 cm X 30 cm (S_3)	10.63	1455.98	77.33
C.D. (P = 0.05)	0.40	65.88	3.84
Crimson Globe (C_1)	9.93	1318.80	65.41
Detroit Dark Red (C2)	10.26	1372.71	92.18
C.D. (P = 0.05)	0.32	53.79	3.14
P*S	0.56	93.17	NS
P*C	NS	114.11	NS
S*C	NS	NS	NS
P*S*C	NS	NS	NS

Table 2: Effect of Planting Time and Spacing on Root Width, Root Length, Root Weight per Plant, Root Yield Per Net Plot and per Hectare and Marketable Root Yield per Net Plot and per Hectare on Beet Root (*Beta vulgaris* L.) Cultivars

	Root Width (cm)	Root Length (cm)	Weight of Beet Root per Plant (g)	Total Root Yield per Hectare (q)	Marketable Yield per Hectare (q)
15^{th} October (P_1)	5.98	5.95	119.33	256.58	155.6
30^{th} October (P_2)	6.82	6.41	139.82	309.28	193.05
15^{th} November (P_3)	6.27	6.50	124.32	261.54	173.01
C.D. (P = 0.05)	0.63	0.43	15.45	40.07	26.8
15 cm X 15 cm (S_1)	5.59	5.55	100.28	358.15	94.71
30 cm X 15 cm (S_2)	6.77	6.46	139.14	309.15	281.89
30 cm X 30 cm (S_3)	6.71	6.86	144.04	160.05	145.06
C.D. (P = 0.05)	0.35	0.25	8.80	19.67	19.55
Crimson Globe (C_1)	6.52	6.18	131.43	286.16	177.71
Detroit Dark Red (C2)	6.20	6.39	124.21	265.44	170.07
C.D. (P = 0.05)	0.29	0.20	7.18	16.06	NS
P*S	NS	NS	12.44	27.81	NS
P*C	NS	NS	NS	NS	NS
S*C	NS	NS	NS	NS	NS
P*S*C	NS	NS	NS	NS	NS

Table 3: Effect of Planting Time and Spacing on Total Soluble Solids and Marketable Shelf Life of Beet Root (*Beta vulgaris* L.) Cultivars

	Total Soluble Solids (°Brix)	Marketable Shelf Life (Days)
15th October (P_1)	12.10	5.67
30th October (P_2)	12.33	5.51
15th November (P_3)	12.09	5.49
C.D. (P = 0.05)	NS	0.13
15 cm X 15 cm (S_1)	11.52	5.55
30 cm X 15 cm (S_2)	12.26	5.57
30 cm X 30 cm (S_3)	12.74	5.56
C.D. (P = 0.05)	0.21	NS
Crimson Globe (C_1)	12.16	5.59
Detroit Dark Red (C2)	12.19	5.53
C.D. (P = 0.05)	NS	NS
P*S	NS	0.13
P*C	NS	NS
S*C	**NS**	NS
P*S*C	NS	NS

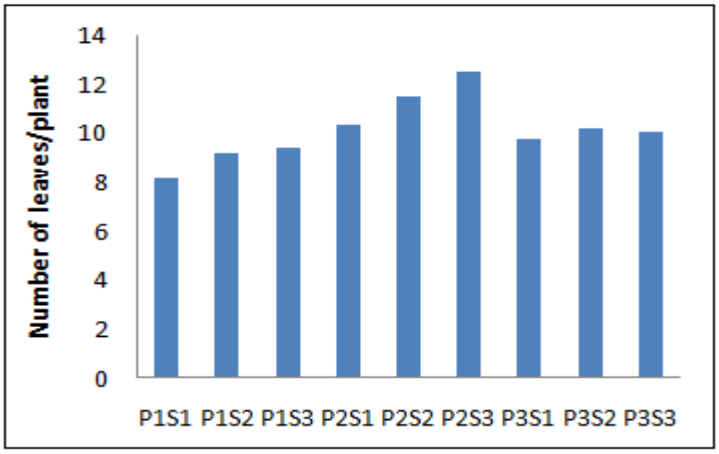

Figure 1: Number of Leaves per Plant as Influenced by P X S Interaction

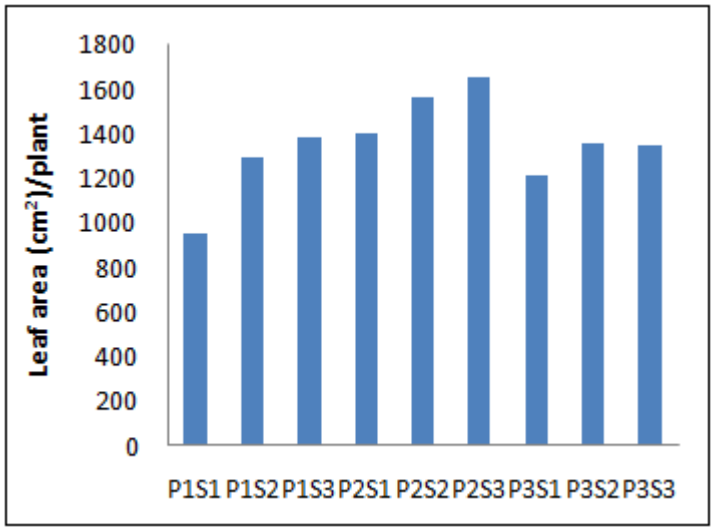

Figure 2: Leaf Area (cm^2) per Plant as Influenced by P X S Interaction

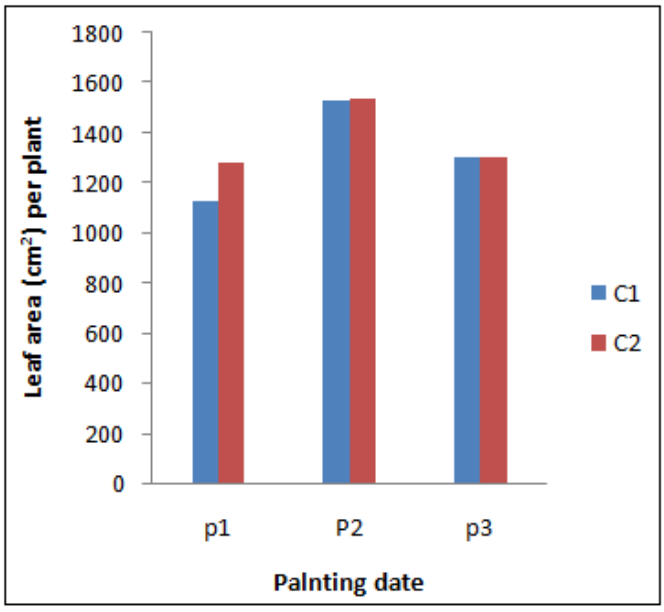

Figure 3: PxC Interaction for Leaf Area (cm^2) per Plant

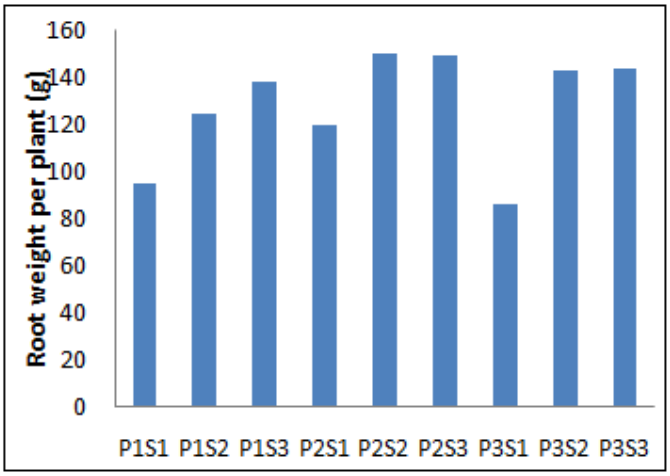

Figure 4: Root Weight per Plant as Influenced by P X S Interaction

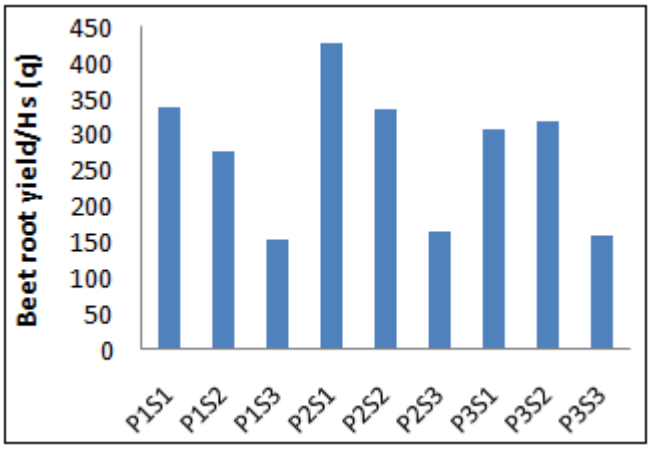

Figure 5: Beet Root Yield per Hectare as Influenced by P X S Interaction